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FOREST PEST MANAGEMENT

United States Department of Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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EXPERIMENT STATION

BIOLOGICAL EVALUATION

R2-85-9

Mountain Pine Beetle Evaluation
State, County, and Private Lands
Casper/Muddy Mountain, Wyoming

1985

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INTRODUCTION

Casper and Muddy Mountains consist of extensive acres of even-aged, 80-90 year old, lodgepole pine in the upper elevations and uneven-aged ponderosa and limber pine on steep, lower elevation slopes. Even-aged stands of lodgepole pine have been created by fire. Based on stand age classes on Casper Mountain, two catastrophic fires occurred covering most of Casper Mountain. The first fire occurred about 1810-1830 and the second about 1875-1895. Because of excess timber on the mountain a third fire could occur in the near future. For example, in 1985 the Red Creek fire consumed several acres in the lodgepole pine type. More fires are likely to occur as mountain pine beetle-caused mortality, combined with increases in mature timber, become more extensive. Fire hazard conditions exist on Muddy Mountain also.

Lessard (1982) determined that the lodgepole pine cover type was at moderate to high risk to mountain pine beetle (Dendroctonus ponderosae Hopk.) and the ponderosa pine cover type was at moderate risk. Low level mountain pine beetle infestations were first detected in the area in 1979. Beetle populations had increased rapidly by 1981 (Lessard 1982). This population increase, combined with risk rating, indicated that up to 65% of the lodgepole pine could be killed by the mountain pine beetle within the next five years (by 1986).

In the spring of 1985, surveys in northcentral Colorado indicated that mountain pine beetle populations were substantially reduced during the winter of 1984-85. Therefore, Pest Management Entomologists 1/ conducted a survey on Casper and Muddy Mountains (Figure 1) during the week of September 23, 1985, to determine if mountain pine beetle population mortality occurred on Casper and Muddy Mountains and if new projections of population trend were needed.

METHOD

Variable radius plots (10 BAF) were established along 1 chain-wide cruise lines at 10 and 5 chain intervals depending on stand size. The following data were collected for each area surveyed.

1/ Gene Lessard, Supervisory Entomologist; Curtis O'Neil, Entomologist; and Jim Kempert, Biological Technician.

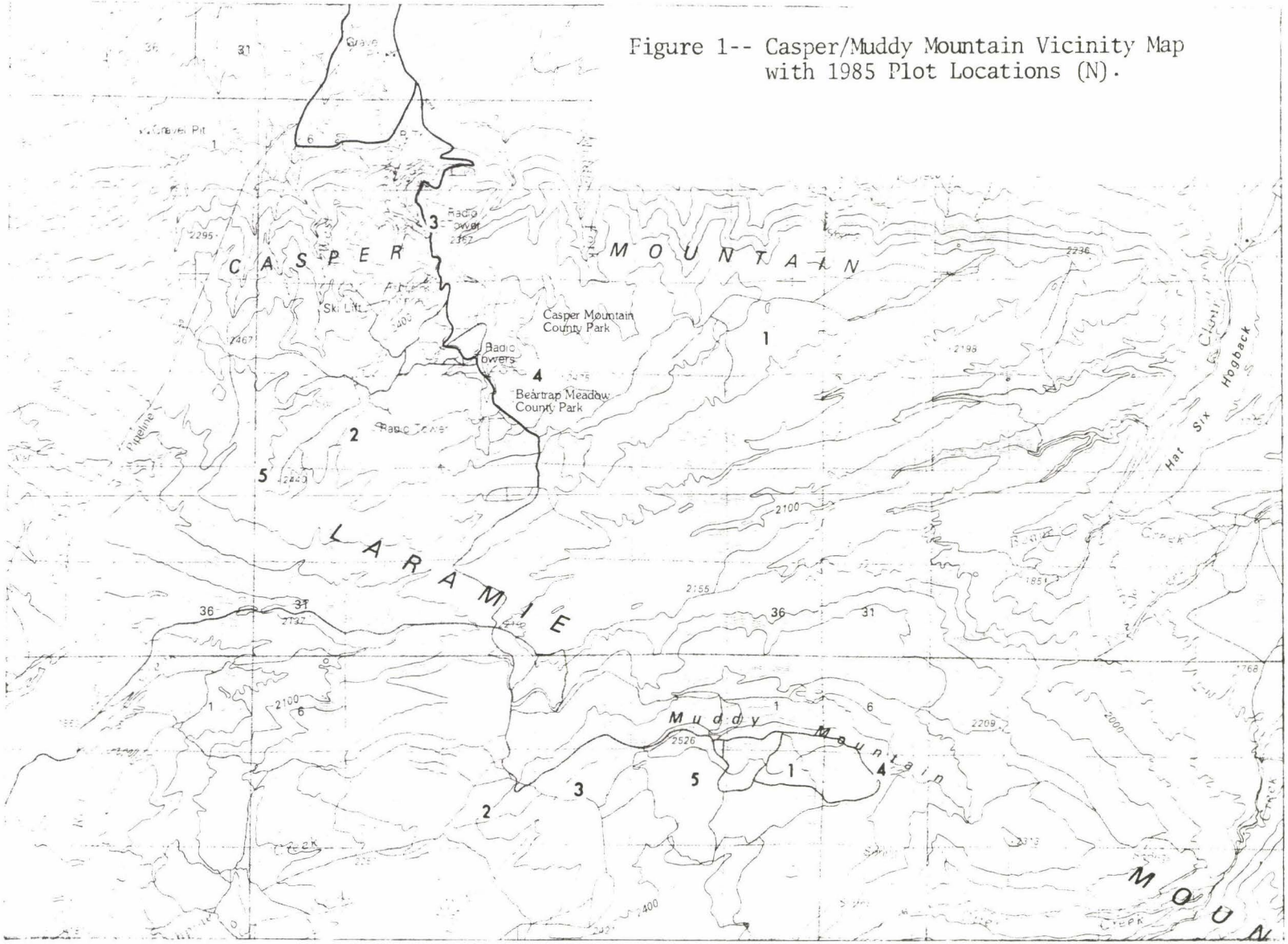


Figure 1-- Casper/Muddy Mountain Vicinity Map with 1985 Plot Locations (N).

1. Strip cruises:

   Diameter (d.b.h. to .1 in.) of lodgepole, limber, and ponderosa pine by the following infestation classes:

   a. 1985 - infested
   b. 1984 - infested
   c. 1983 - infested
   d. pitchouts

2. Variable plots:

   a. Diameter of green uninfested lodgepole, limber, and ponderosa pine
   b. Diameter of all aspen and fir

All attacked trees were tallied by year of attack. Attack ratios were calculated to see if the number of new to old attacks had increased, decreased, or remained static.

RESULTS AND DISCUSSION

Muddy Mountain

Lodgepole pine -- On Muddy Mountain, mountain pine beetle-caused tree mortality increased from 1983 to 1984 more than fivefold from 2.86 to 15.25 trees per acre (Table 1). As suspected, mountain pine beetle population mortality occurred in the winter of 1984-85 causing a decline of infested trees from 1984 to 1985 of about 45 percent to 8.43 trees per acre. Tree mortality occurred mainly in the diameter range of 8 to 13 inches (d.b.h.). The average diameter of infested trees declined each year from 1983 to 1985 (Table 3).

Table 1. Lodgepole pine per acre infested and attack ratio, Muddy Mountain, 1985

	1985	1984	1983
Infested Trees/Acre	8.43	15.25	2.86
Attack Ratio	1985:1984		1984:1983
	.6:1		5.3:1

Mountain pine beetle generally kill more large diameter than small diameter lodgepole pine (Cole and Amman, 1969) and trees of largest diameter each year until the infestation dies out. This selective

attack on larger trees is evident on Muddy Mountain. Residual stands consist mainly of trees in the lower diameter classes (Figure 2). The average diameter of trees in the residual stand is 8.3 inches (d.b.h.). This means that further risk to mountain pine beetle has generally decreased from a high to a moderate risk category. Therefore, the future trend of mountain pine beetle on Muddy Mountain should continue to decrease over the next 5 to 10 years.

Casper Mountain

Lodgepole pine -- On Casper Mountain, mountain pine beetle-caused tree mortality increased slightly from 1983 to 1984 (Table 2). As on Muddy Mountain winter mortality to the beetle caused a decline of infested trees of nearly 80 percent from 1984 to 1985. The average diameter of infested trees increased from 1983 to 1984 and decreased from 1984 to 1985 (Table 3).

Table 2. Lodgepole pine per acre infested and attack ratio, Casper Mountain, 1985

	1985	1984	1983	1982	1981	1980
Infested Trees/Acre	.64	2.92	2.56	N/A	7 2/	0 2/
Attack Ratio	1985:1984 .2:1		1984:1983 1.1:1			

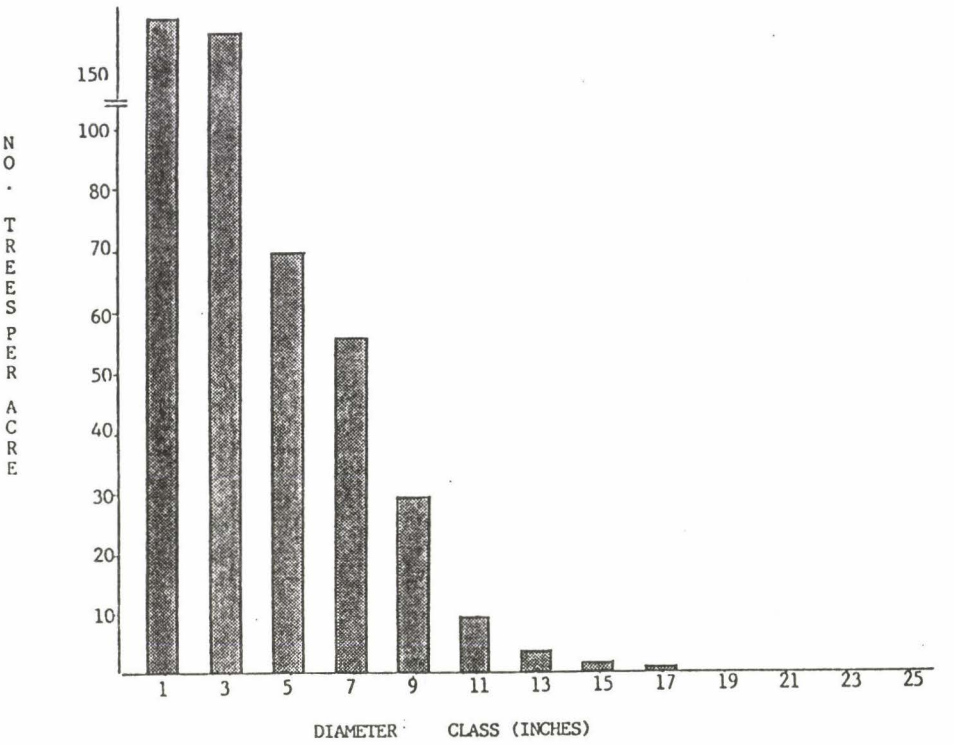
2/ Number of trees infested (Lessard, 1982)

Table 3. Average Diameter of Mountain Pine Beetle-Infested Trees, 1983-85

	1985	1984	1983
Muddy Mountain			
$\bar{x}$ d.b.h. LP	9.8	10.4	10.8
Casper Mountain			
$\bar{x}$ d.b.h. LP	10.6	13.2	12.0
$\bar{x}$ d.b.h. PP	0	23.7	0

LP = Lodgepole pine
PP = Ponderosa pine
$\bar{x}$ = Mean Diameter

Figure 2. Residual Lodgepole Pine Diameter Distribution, Muddy Mountain, 1985



The residual stand diameters on Casper Mountain (Figure 3) differ substantially from those on Muddy Mountain. There are more trees in the larger diameter classes than the smaller classes. The average diameter of the residual is 8.6 inches (d.b.h.) but, the distribution of diameters makes the majority of the stands high risk to mountain pine beetle. Therefore, the future trend of mountain pine beetle in lodgepole pine on Casper mountain should be as earlier predicted (Lessard 1982). That is, beetle populations should resume an upward trend in 1986 or 1987 and losses to the lodgepole pine cover type could reach 65% by 1991.

Ponderosa pine -- Mountain pine beetle-caused tree mortality in the one stand surveyed had 0.67 trees per acre infested in 1984. Tree mortality in 1983 and 1985 was zero. This is not representative of the ponderosa pine cover type on Casper Mountain. However, the distribution of trees by diameter class (Figure 4) is representative of the type. Mountain pine beetle-caused mortality is expected to occur primarily in the 7 to 13 inch diameter classes (Lessard 1982). This will produce an irregular uneven-aged distribution in this type. Expected losses over the next 5-7 years could exceed 40% of the cover type.

Table 4. Ponderosa Pine Per Acre Infested and Attack Ratio, Casper Mountain, 1985

	1985	1984	1983
Infested Trees/Acre	0	.67	0
Attack Ratio	N/A	N/A	N/A

SUMMARY

Casper and Muddy Mountain continue to be at moderate to high risk to mountain pine beetle. Over the past 3-4 years, mountain pine beetle tree mortality has changed the susceptibility of lodgepole pine stands on Muddy Mountain from a high to a moderate risk category by reducing the number of larger diameter trees. This implies a declining trend of mountain pine beetle attacks and subsequent tree mortality in the next 5 to 10 years. Residual tree diameter distributions on Casper Mountain consist of more larger lodgepole pine that can sustain mountain pine beetle populations and an ongoing upward trend in tree mortality. This is a high risk condition to mountain pine beetle. Therefore, projected losses of up to 65% of the lodgepole pine type could occur in the next 5 years. These losses will continue to cause further increase in the high fire potential in the area, particularly on Casper Mountain.

Figure 3. Residual Lodgepole Pine Diameter Distribution, Casper Mountain, 1985

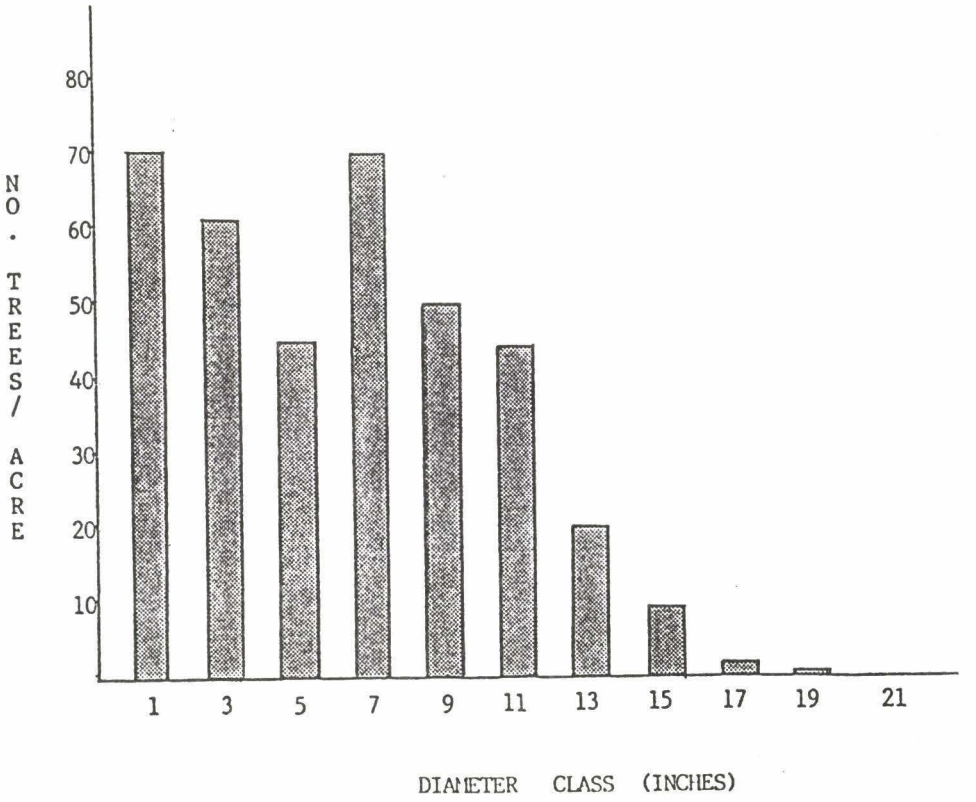
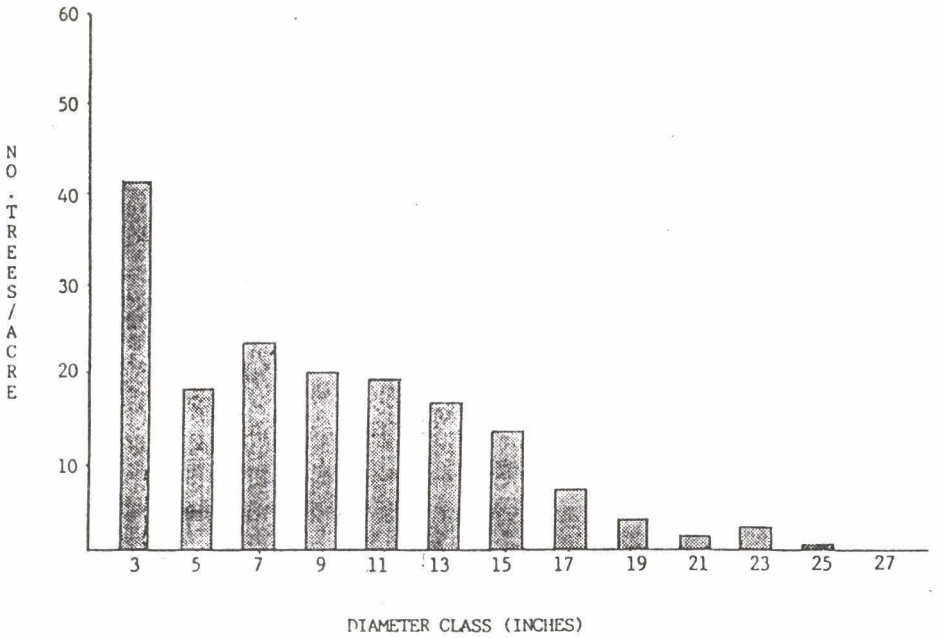


Figure 4. Residual Ponderosa Pine Diameter Distribution, Casper Mountain, 1985



Recent winter mortality to the beetle temporarily reduced beetle populations but has not effected the stand conditions which are capable of supporting resurgence of populations. Hence, projections of the infestation trend is not strongly affected by recent mortality to the beetle.

The management alternatives presented to reduce losses to mountain pine beetle and fire potential are based on increasing the following: diversity of forest types; age and size classes; and acres of broken forest and canopy continuity. These all increase overall forest diversity and can be achieved through current methods available to land managers.

ALTERNATIVES

A biological evaluation prepared in 1981 presented management alternatives for the Casper/Muddy Mountain area. The alternatives for the 1981 evaluation remain valid - they are:

1. Do nothing.
2. Clearcut or group selection and encourage natural regeneration.
3. Clearcut or group selection and plant.
4. Shelterwood cut and encourage natural regeneration.
5. Thinning from above.
6. Thinning small diameter stands ($\leq$7.0 in. d.b.h)
7. Apply any combination of the above.

Specifications and benefits of the above alternatives are provided in Appendix A.

REFERENCES

Amman, G. D., M. D. McGregor, D. B. Cahill, and W. H. Klein. 1977. Guidelines for reducing losses of lodgepole pine to the mountain pine beetle in unmanaged stands in the Rocky Mountains. USDA For. Serv. Gen. Tech. Rep. INT-36, 19 pp.

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Stevens, R. E., W. F. McCambridge, C. B. Edminster. 1980. Risk rating guide for mountain pine beetle in Black Hills ponderosa pine. USDA For. Serv. RMFRES Res. Note RM-385, 2 pp.

APPENDIX A - Risk Rating Criteria
Management Alternatives

APPENDIX B - Casper/Muddy Mountain Maps

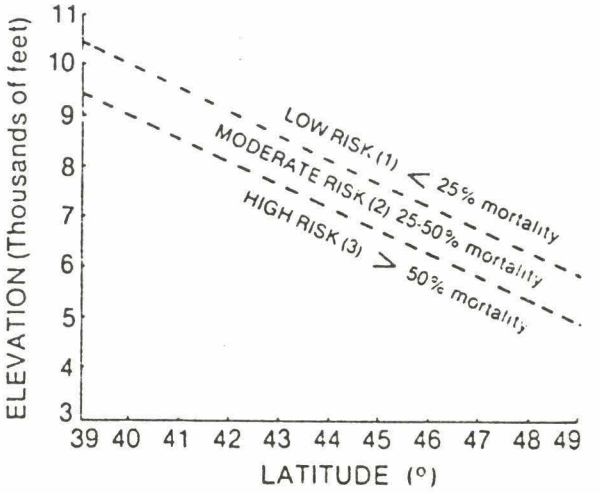
APPENDIX C - Data Tables and Figures

APPENDIX A

Lessard (1981) used the following risk rating schemata for lodgepole pine (Amman, et. al. 1977) and ponderosa pine (Stevens, et. al. 1980) to evaluate the susceptibility of lodgepole and ponderosa pine stands on Casper Mountain. Risk rating was also useful in formulating the management alternatives.

The latitude for Casper Mountain ranges from 42° 42' to 42° 45' or about 42.75°. Elevations range from about 7000 feet to just above 8000 feet. At a latitude of 42.75° all stands less than 8000 feet in elevation are assigned a risk factor of 3; and, stands greater than 8000 feet are assigned a risk factor of 2 (Figure 2). Since the elevational zone does not extend to 8700 feet, a low risk for this parameter cannot be assigned to stands on Casper Mountain.

Figure A-1--Risk of mountain pine beetle infestation in lodgepole pine can be defined by zones of elevation and latitude. Percent mortality is for trees 8.5 inches d.b.h. and larger.



Risk factors for average stand age (years) and diameter (inches) are tabulated below:

Table A-1 -- Risk Factors for Age and Diameter in Lodgepole Pine

Average Age (Years)	Risk Factor	Average d.b.h. (Inches)	Risk Factor
<60	(1)	<7	(1)
60-80	(2)	7-8	(2)
>80	(3)	>8	(3)

Stands given an overall susceptibility classification of low can be expected to sustain lodgepole pine tree losses of less than 25% for trees in excess of 8.5 inches diameter; moderate 25-50%; and, high greater than 50%.

Alternatives

1. Do nothing: This alternative is the no management alternative. It is predicted that mountain pine beetle will continue to cause loss of a large percentage of trees larger than 7.0 inches diameter. It is also predicted that the potential for fire will increase due to increased fuel (beetle-killed trees) and maintenance of a continuous forest canopy.

2. Clearcut or group selection and encourage natural regeneration: Since lodgepole pine, in most cases, requires a fire to open seed cones, the probability of natural regeneration is small. Natural regeneration from fir, if a seed source is available, would not only produce forest cover but also reduce the future risk to mountain pine beetle. Two prominent problems with fir on Casper Mountain are fir broom rust and root rot. The impact of these pathogens can be minimized by maintaining young, vigorous stands. Another possibility would be to clearcut mixed aspen lodgepole pine stands to stimulate aspen regeneration. This is accomplished by removing all lodgepole pine and aspen to stimulate aspen sprouting.

3. Clearcut or group selection and plant: This alternative is identical to alternative 2 except the clearcut area is planted with native trees and/or shrubs. Shrub plantings could be used to improve wildlife habitat while a new forest is being regenerated.

Note: Both clearcut alternatives involve removing all trees from a designated portion of the property being managed. Clearcutting the entire property is not recommended. Clearcut patches (group selection) could be as small as 150 feet in diameter and as large as an acre. The purpose in clearcutting is to establish a series of small even aged stands with each patch containing a different age class. Consider making one to four small clearcut patches every five years.

4. Shelterwood cut and encourage natural regeneration: This alternative involves removal of a percentage of the trees leaving only the larger, disease-free trees to supply a natural seed source. The problems inherent in lodgepole pine regeneration in alternative 2 apply

here. If too many trees are removed, the possibility of windthrow could cause an additional problem. Windthrow can be minimized by removing a small percentage of trees each year until the desired results have been achieved. The residual seed trees pose the same risk to mountain pine beetle as before management except that some increase in individual tree vigor should reduce susceptibility by a slight degree.

5. Thinning from above: This alternative is really the reverse procedure outlined in alternative 4. The exception is that natural regeneration would not be expected to develop until the residual stand matures and produces a cone crop. It involves removing all of the large overstory trees. This alternative could be applied over the entire property in one year with little risk to windthrow if relatively few (20% or less) of the trees on the property are large, overstory trees. This alternative could substantially reduce the susceptibility to mountain pine beetle by reducing average stand diameter.

6. Thinning small diameter stands (less than 7.0 inches): This alternative would be applied where there are no distinct overstory trees and little or no dwarf mistletoe. It involves removing a percentage of the trees on the property to increase the vigor of the residual trees. This alternative would also be applied to young stands created by applying alternatives 1-4 and as residual stands in alternative 5 increase in diameter. Growth response to thinning will increase susceptibility to mountain pine beetle over time.

7. Apply combinations of alternatives 1-6 to increase diversity of the forest type, lodgepole pine age and diameter classes.

Ponderosa Pine - Three parameters are used to determine stand susceptibility to mountain pine beetle:

1. Stand structure
2. Average stand diameter (d.b.h. inches)
3. Average stand density (sq.ft. per acre)

As in the guidelines for lodgepole pine, risk factors are assigned to each parameter. The risk factors are multiplied together to produce the following susceptibility classification: low = 2 to 6; moderate = 8 to 12; high = 18 to 27. The three parameters and corresponding risk factors are tabulated below:

TABLE A-2 - MPB Risk Classes for Black Hills Ponderosa Pine

	Risk Classes		
	1 = low	2 = moderate	3 = high
Stand structure	-	2-storied	single-storied
Average stand d.b.h. (inches)	<5	6-10	>10
Stand density (square feet per acre)	>80	80-150	>150

There is no suitable risk rating system for ponderosa pine stands on Casper Mountain. The risk rating system in the Black Hills was used to obtain the moderate risk rating. Ponderosa pine stands with a diversity of size and age classes will sustain less losses than even-aged, uniform diameter stands. The diameter distribution in ponderosa pine shows good diversity in size classes. Age measurements indicate two dominant age classes 80 years old and 170 years old.

Alternatives

1. Do nothing: Same as alternative 1 for lodgepole pine.

2. Harvest overmature trees (large diameter trees greater than 25.0 inches): This involves removing large diameter trees and planting ponderosa pine seedlings. Plantings should be done over time to increase size and age diversity. As the new plantings grow into large diameter classes, additional overmature trees should be harvested (18.0 - 20.0 inches).

3. Shelterwood cut and encourage natural regeneration: This alternative involves removal of a percentage of the trees leaving only the larger trees to provide a seed source. Risk of windthrow in ponderosa pine is substantially less than that of lodgepole pine. Since fire is not required to open cones, natural ponderosa pine regeneration should be more substantial than lodgepole pine.

4. Thinning small diameter stands: This alternative is the same as alternative 6 for lodgepole pine.

APPENDIX B

Fig. B-1 -- Red Creek Fire and Mountain Pine Beetle Distribution from 1985 Aerial Survey, Casper Mountain, Wyoming.

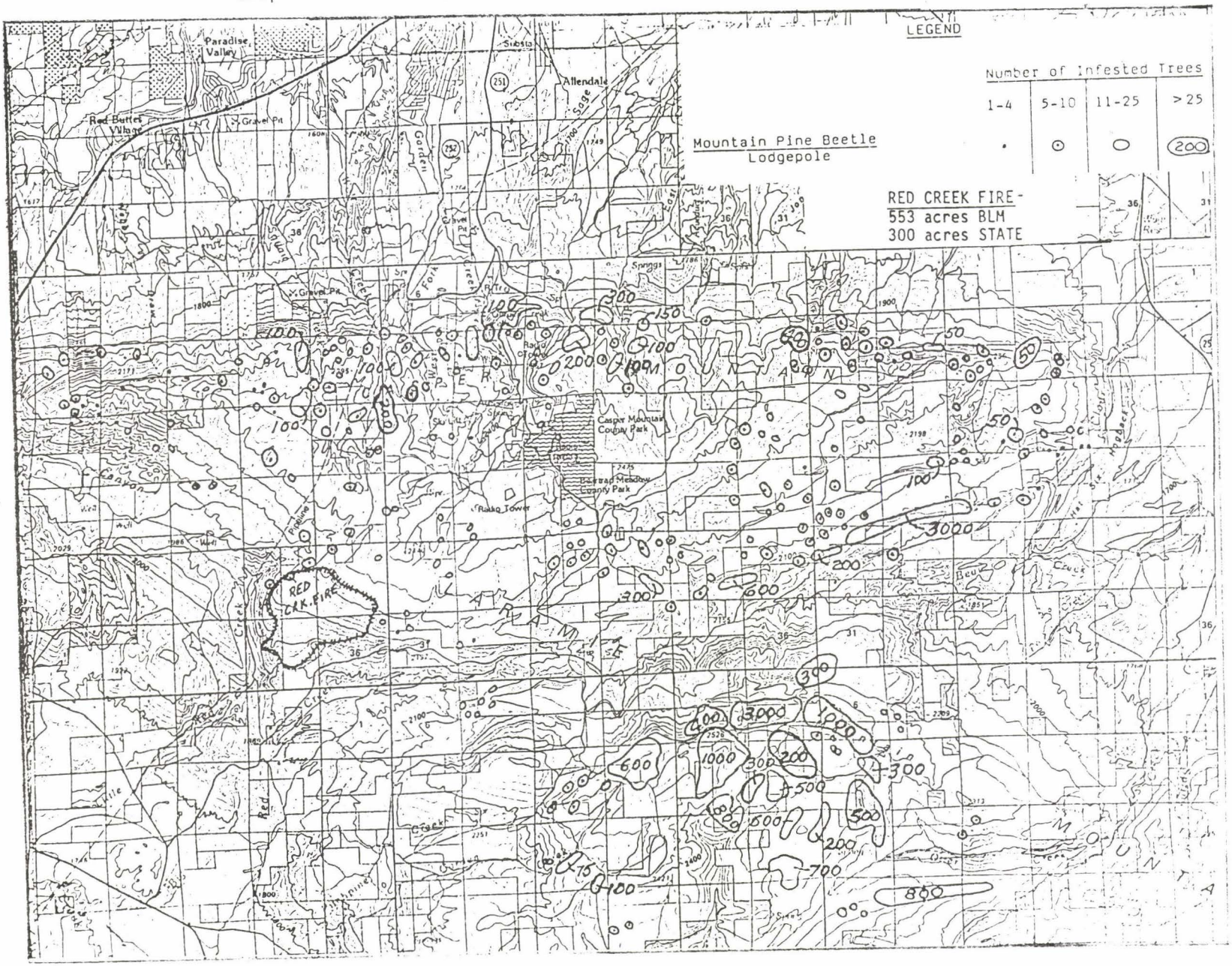


Table 1. Data Summary of all Stands Surveyed on Casper Mountain, including Total Number of Plots and Number of Mountain Pine Beetle Infested Trees by Year of Attack, Casper Mountain, Wyoming

No. Plots	Uninfested			1985 Infested		1984 Infested		1983 Infested		Pitch Out		Basal Area	Age	Aspen	Fir
	LP	LM	PP	LP	LM	LP	PP	LP	LM	LP	LM				
36	301	13	74	14	-	33	6	13	-	13	-			25	16
												125	80+		
x ± S.E.	10.4 ±.35	11.0	14.4 ±.86	10.6	-	13.0 ±.94	25.5	13.0	-	11.0	-			5.0	8.3

Table 2. Data Summary of Stands Surveyed on Muddy Mountain, including Total Number of Plots and Mountain Pine Beetle Infested Trees by Year of Attack, Muddy Mountain, Wyoming

No. Plots	Uninfested		1985 Infested		1984 Infested		1983 Infested		Pitch Out		Basal Area	Age	Aspen	Fir
	LP	LM	LP	LM	LP	LM	LP	LM	LP	LM				
44	262	31	320	1	464	13	86	6	169	13			40	15
											76	80+		
x ± S.E.	8.0 ±.42	9.0 ±.38	10.5± 1.7	10.5	10.0 ±.28	12.7	10.0±.6	15.8	9.6±.6	11.0			7.1±.76	8.3

X = Mean DBH ± S.E. at t.05d (S.E. not determined for N < 30)
LP = Lodgepole
LM = Limber
PP = Ponderosa

Table 3. Summary of Diameters, Basal Area, and Trees Per Acre from Variable Plots on Casper and Muddy Mountains, Wyoming, 1985

	Unit	No. Plots		Diameter (DBH - Inches)					Basal Area					Trees Per Acre				
				LPP	LIM	FIR	ASP	PP	LPP	LIM	FIR	ASP	PP	LPP	LIM	FIR	ASP	PP
Casper Mountain	1	10		8.7	9.9	8.4	4.2	-	80	-	3.0	7.0	-	192.0	-	6.6	34.5	-
	2	8		11.4	12.1	-	5.7	-	82.0	-	-	7.5	-	134.0	-	-	31.3	-
	3	8		-	8.0	-	-	14.1	-	-	-	-	91.2	-	-	-	-	111.0
	4	8		11.7	-	7.0	5.1	-	134.6	-	16.2	3.7	-	188.7	-	60.2	18.4	-
	5	2		9.1	-	-	-	-	205.0	-	-	-	-	410.0	-	-	-	-
			$\bar{X}$	8.6	10.0	7.3	4.4	14.1	125.0	-	9.6	6.0	91.2	231.0	-	-	-	-
Muddy Mountain	1	8		4.6	-	9.6	5.2	-	26.2	-	7.5	3.7	-	71.0	-	18.0	17.0	-
	2a	4		7.6	5.7	14.5	-	-	55.0	7.5	2.5	-	-	185.0	32.5	1.9	-	-
	2b*	4		9.4	-	-	-	-	80.0	-	-	-	-	169.0	-	-	-	-
	3	10		7.4	8.6	-	7.4	-	63.0	11.0	-	8.0	-	188.0	31.4	-	23.6	-
	4	10		7.3	9.4	6.7	6.4	-	92.0	5.0	4.0	17.0	-	201.0	8.5	15.3	50.5	-
	5	8		9.2	11.2	6.5	8.0	-	84.6	30.0	5.0	11.2	-	37.0	38.0	17.0	27.5	-
			$\bar{X}$	8.3	9.8	8.3	6.4	-	67.0	13.4	4.7	10.0		156.0	27.6	13.5	29.6	

LPP - Lodgepole pine
LIM - Limber pine
PP - Ponderosa pine
ASP - Aspen
$\bar{X}$ - Mean

* - Cut unit

Table 4. Summary of Strip Cruise Data Showing Diameter of Trees Attacked; Trees Per Acre Attacked; and Attack Ratios by Year, Muddy Mountain, 1985

	Diameter by MPB Attack Class				No. Trees Attacked				No. Attacked Trees/Acre				Attack Ratio (Trees/Acre)	
Plot	1985 Attack	1984 Attack	1983 Attack	Pitch Out	1985	1984	1983	Pitch Out	1985	1984	1983	Pitch Out	'85:84	'84:83
1	9.7	11.1	13.0	10.7	60	113	16	16	10.0	18.83	2.67	2.67		
2	10.0	11.0	8.3	9.6	16	4	6	9	5.33	1.33	2.00	3.00		
3	8.8	8.5	10.3	8.4	41	167	41	26	5.86	23.86	5.86	3.71		
4	11.6	13.1	12.7	10.4	51	45	3	32	12.75	11.25	.75	8.00		
5	9.2	8.3	9.5	11.8	41	105	15	22	8.20	21.00	3.00	4.40		
Mean	9.8	10.4	10.8	10.2	41.8	86.8	16.2	21.0	8.43	15.25	2.86	4.36	.55:1.0	5.3:1.00

MPB ATTACKS ON LIMBER PINE

Plot	1984 Attack	1983 Attack		No. Trees Attacked 1985	1984	1983
1	16.7	-	-	-	3	-
3	11.7	9.0	-	-	9	2
5	15.0	-	-	-	2	-
Mean	14.4	-	-	-	4.6	2.0

Table 5. Summary of Strip Cruise Data Showing Diameter of Attacked Trees; Number of Trees Attacked Per Acre; and Attack Ratios by Year, Casper Mountain, 1985

Plot	Diameter by MBP Attack Class				No. Trees Attacked				No. Attacked Trees/Acre				Attack Ratio (Trees/Acre)	
	1985 Attack	1984 Attack	1983 Attack	Pitch Out	1985	1984	1983	Pitch Out	1985	1984	1983	Pitch Out	'85:84	'84:83
1	10.5	12.7	10.6	-	2	8	2	0	.25	1.0	.25	0		
2	11.6	13.8	-	10.0	2	2	0	2	.33	.33	0	.33		
* 3	-	23.7	-	-	0	4	0	0	0	.67	0	0		
4	10.0	13.0	-	11.5	3	7	0	7	1.00	2.33	0	2.33		
5	10.6	13.5	13.2	-	1	8	10	0	1.00	8.00	10.00	0		
Mean	10.6	13.2	12.0	10.7	2.0	6.25	3.0	2.25	.64	2.92	2.56	.66	.22:1.0	1.14:1.0

* All ponderosa pine - not included in Mean